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Measurements of Solar Radiation Instruments and Some Results

By Ladislas Gorczynski, D.Sc.
(*Member of the International Commission of Solar Radiation*)

Introduction

Nobody will deny that in the series of meteorological elements solar radiation takes the predominant place. Nevertheless, we note the strange fact that of the many thousand meteorological stations in the world, a negligible number are making actinometric measurements.

The reason for this very unsatisfactory state of things is not an underestimation of the importance of solar radiation studies, but rather the lack of simple actinometers giving sufficiently reliable data on a determined scale. It is obvious that for daily observations at ordinary meteorological stations and for general use for those interested (agriculturists, botanists, medical men, etc.) only simple instruments can be employed. One needs an apparatus that will directly indicate the momentary values of radiation intensity like a thermometer or an anemometer. This objective is nearly gained by using thermopiles for solar radiation work. That cannot be claimed for some other methods, which, though simple in use, present very serious defects and cannot give us sufficiently comparable data. The reliability of the observations, obtained for instance with so-called " radiation thermometers " consisting of a

black bulb in vacuo and so extensively used in some large sunny parts of the British Empire is so doubtful that these small instruments can now hardly be recommended. On account not only of simplicity but also of reliability, thermo-electric actinometers make possible the realization of the wish of meteorologists of all countries to include solar radiation measurements in daily routine observations, like other regular readings of air temperature, pressure, wind, etc.

I emphasize finally the scientific and practical importance of measurements of the sun and sky radiation not only at meteorological stations, but also for agriculture and for botanists, for photography (e.g. for determining the proper time exposure) and for different medical purposes (climatology and especially actinotherapy). It is even possible to apply the thermo-electric method to the study of smoke effects in big towns and agglomerations and also to aviation ; in this way one can rapidly obtain an idea of the transparency and thickness of clouds and fogs.

Part I

(a) *Actinometers for direct readings.*—Under the general name of actinometers are included all instruments for measurements of the intensity of solar radiation. For different kinds of actinometers, the following classification may be used.

(1) Pyrheliometers (or pyrheliographs) for measurement of the intensity of radiation received directly from the sun's disc upon a surface normally exposed to the solar rays.

(2) Solarimeters (or solarigraphs) for the total intensity of solar radiation coming not only directly from the sun but also diffused by the whole sky.

Special instruments like the diffusometer or diffusograph, albedometer, etc. (pyranometer corresponds in most cases to solarimeter) belonging mostly to the second group, may also be mentioned here. But a separate and very important group must be reserved for investigations of the solar spectrum by means of special spectrographs, spectrobolometers, etc. In order to save space, we cannot enter here into further details concerning spectral researches.

The pyrheliometers and solarimeters described in this paper are based on the thermo-electric method. I use special thermopiles (of Moll type, constructed by P. J. Kipp & Zonen, Delft, Holland) connected with simple needle galvanometers (e.g. millivoltmeters of Jules Richard in Paris, Cambridge recorders, Weston or others*).

* A description of solarimeters and solarigraphs may be found in my papers in the *Monthly Weather Review* (54, 1926, p. 381), and of pyrheliographs in the *Monthly Weather Review* (52, 1924, p. 299). See also my contribution in the *Quarterly Journal of the Royal Meteorological Society* (52, 1926, p. 210). Some new patterns of these instruments together with a study of the solar climate of Mediterranean shores are described in the following papers: (1) Climat solaire de Nice et de la Côte d'Azur (Nice, 1934) and (2) Enregistrements du rayonnement solaire au moyen des solarigraphes et des pyrheliographes (Nice, 1934).

FIG. 1.—SOLARIMETER WITH PYRHELIOMETRIC TUBE

Mounted on an equatorial stand and connected with a needle-galvanometer (millivoltmeter type).

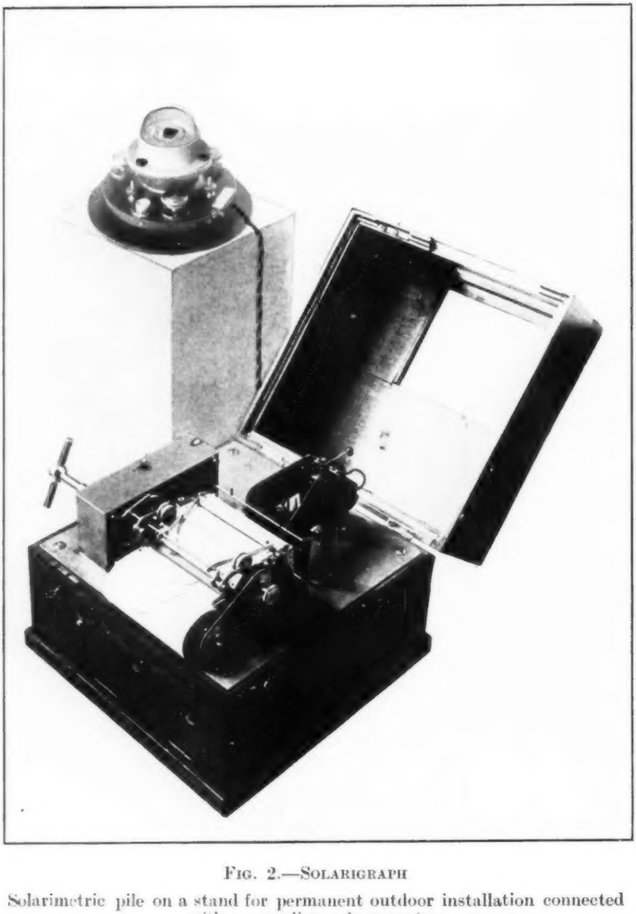

Fig. 2.—Solarigraph

Solarimetric pile on a stand for permanent outdoor installation connected with a recording galvanometer.

In the pyrheliometers or pyrheliographs the thermopile, enclosed in a cylindrical tube with diaphragms, is exposed normally to the rays coming directly from the sun. On the contrary, the thermopile destined for solarimetric or solarigraphic use has no tube and is freely exposed to the sun's rays coming directly from the sun and diffused by the whole sky.

Fig. 1 shows a recent pattern of an actinometer for direct readings, where a single thermopile, placed under a hemispherical glass cover, can be employed either for pyrheliometric (with a movable tube) or for solarimetric use (without any tube).

As shown in Fig. 1, the instrument can be used in three different ways, viz. :—

1. = PYRH. Instrument employed as pyrheliometer for measurement of solar radiation as received directly from the sun at normal incidence.

In this case the movable tube (shown in part 1 in a slightly displaced position, is placed on the thermopile and directed normally to the sun by means of an ordinary sight. The galvanometer deviation is read while the tube is open to the sun's rays ; the " zero " position of the galvanometer (metallic shutter covering the tube) is determined twice, before and immediately after each reading of the deviation produced by the sun. The rotating disc, placed at the end of the pyrheliometric tube, makes easy the employment of light filters. Four openings are made for this purpose ; one is destined to pass freely all the solar rays, while three others are fitted with coloured glass filters (mostly red, black and blue).

2. = SOL. Instrument employed as solarimeter for measurement of the total (sun and sky) radiation on a horizontal surface.

In this case the movable tube is removed and the thermopile is placed horizontally as shown in part 2 = SOL of Fig. 1. The galvanometer deviation then obtained results not only from direct solar rays, but also from diffused sky radiation coming from the whole sky to the hemispherical glass cover of the thermopile. The " zero " reading of the galvanometer, always connected with the pile, is obtained by completely covering the thermopile.

3. = DIFF. Instrument employed as diffusometer for measurement of sky radiation only.

In this case a special screen (sun's mask) is employed, as shown in part 3 of Fig. 1. The screen mask should be conveniently turned and placed so that the shadow from the opaque disc of the screen mask appears distinctly on the thermopile protecting it from the direct solar rays.

Moreover, this pattern is fitted—at the end of the movable tube—with a rotating disc (visible on Fig. 1) which contains three coloured glasses as light filters and an opaque screen as metallic shutter. The last one serves to intercept completely the sun's rays in order to determine the corresponding " zero " or " shadow " position of the galvanometer connected with the thermopile.

The metallic equatorial stand on which the thermopile is placed, contains a circle graduated in degrees which enables one to read directly the sun's altitude ; a spirit level and three adjusting screws readily permit the whole instrument to be placed horizontally.

(b) *Recording Actinometers* (*Solarigraphs, pyrheliographs, etc.*).—The solarimeters are employed not only as portable instruments for direct readings (Fig. 1) but also as solarigraphs for permanent registration of the total (direct and diffuse) solar radiation. For this purpose (see Fig. 2) the solarimetric pile, closed almost hermetically under a hemispherical glass cover and placed on a simple stand, is installed out of doors (e.g. on a tower, terrace or simply on a roof in a convenient place). The pile is connected with a recording galvanometer, placed indoors in a room where the temperature variations are not excessive. The accidental deposit of some water drops upon the inner parts of the glass cover can be avoided by changing, from time to time, the small quantity of hygroscopic substance introduced in the interior of the pile mounting. The small scent bag with this substance can be easily removed and replaced by a fresh one. For this purpose the lower part of the pile mounting should be unscrewed.

Millivoltgraphs of Etabl. Jules Richard in Paris, tested in calories with corresponding thermopiles by the Observatoire du Parc Saint-Maur are in common use. The Cambridge Thread Recorder has been used in the Meteorological Office and arrangements are being made for the manufacture of complete recording instruments by Messrs. C. F. Casella & Co., London. These will be certified at the National Physical Laboratory, Teddington. I mention also here the recording potentiometers of Leeds and Northrup, Philadelphia, U.S.A., though this excellent method is delicate for practical use.

In Fig. 3 (*a*) and (*b*) we find two solarigraphic diagrams obtained, with a Cambridge Recorder at South Kensington (Instrument Division of the Meteorological Office, London), with a nearly clear sky and with broken cloud*. It is interesting to note that even with a totally covered sky we find always some small but characteristic deviations by means of solarigraphs, when the normal pyrheliometer gives no indication at all.

In such cases, when the hourly variations are of less importance than the data concerning the total solar radiation received in a given interval of time (for the whole day or partially between each observation), an integrating device (see the corresponding illustration in Fig. 4) can be used. In this case the solarimetric thermopile for outdoor installation is connected to a special milliampere-hour indicator of high sensitivity. With this apparatus a difference in height of the liquid column of about 2 in. (50 mm.) may be easily

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* I am very indebted to the Director of the Meteorological Office for kind permission to reproduce here these two solarigraphic diagrams obtained at South Kensington.

[*facing p. 4*

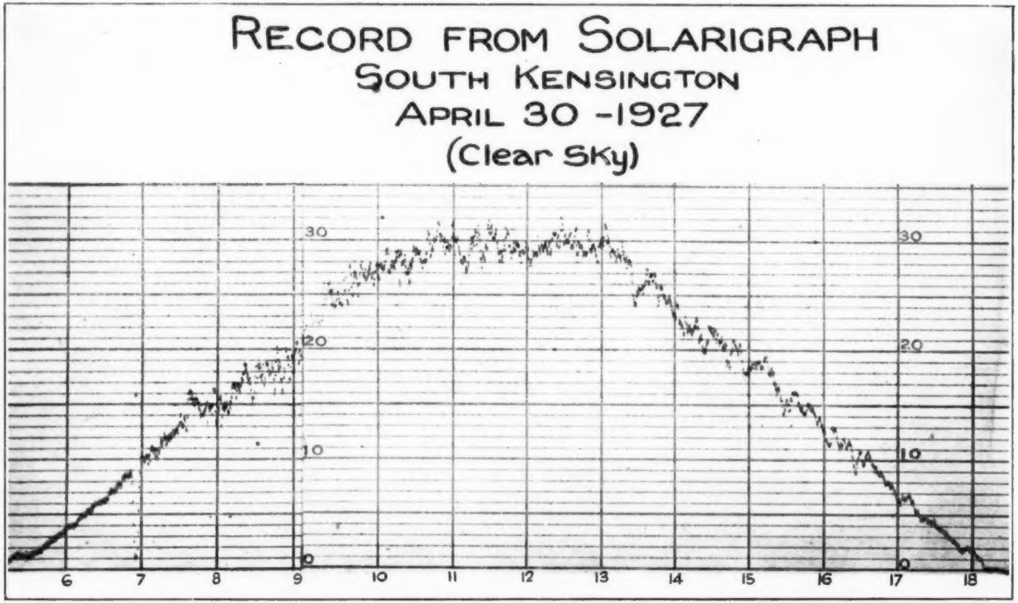


FIG. 3(a).—SOLARIGRAPHIC RECORDS OBTAINED AT SOUTH KENSINGTON WITH NEARLY CLEAR SKY.

The abscissae of the diurnal diagrams used for solarigraphs represent the hours (true solar time) and the ordinates the divisions obtained with a Cambridge recorder connected with the solarigraphic pile placed out of doors on a stand.

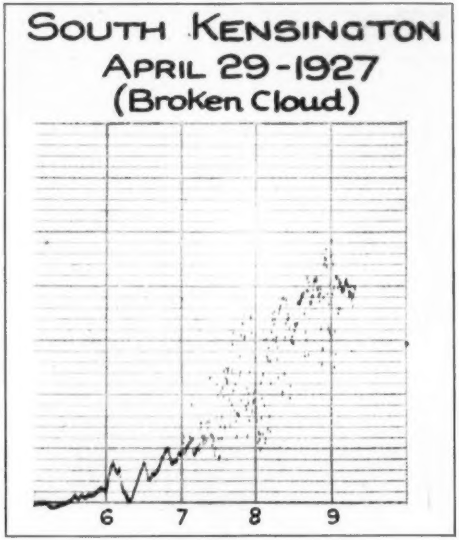


FIG. 3(b).—SOLARIGRAPHIC RECORDS OBTAINED AT SOUTH KENSINGTON WITH BROKEN CLOUD.

For explanation see Fig. 3(a) facing p. 4.

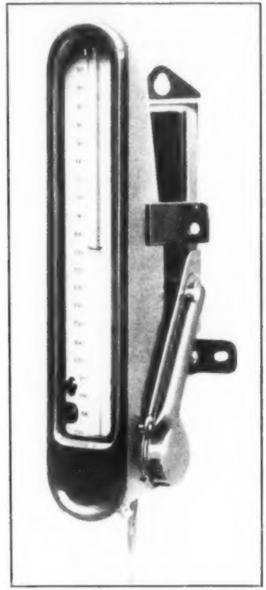


FIG. 4. AN INTEGRATING MILLIAMPERE-HOUR INDICATOR.

A very useful device for stations where the installation of a recording galvanometer is too difficult or too expensive.

obtained, when measuring over the whole day and with ordinary sky conditions prevailing in the temperate zone. By a simple manipulation the milliampere-hour indicator can be brought to zero again, after each daily observation. The value in calories of one division of the indicator scale is given for each integrating solarimeter.

The solarigraph duly transformed can be also adapted for recording diffuse radiation only. Such a diffusograph may be easily obtained by using a " sun mask " (see part 3 of Fig. 1), but, instead of moving it by hand, it should be placed on an equatorial mounting like that used for pyrheliographs. In this manner the screen (sun mask) follows the sun automatically, permanently shading the solarimetric pile immovable on its stand.

In order to save space, I cannot enter here into further details concerning diffusographs and pyrheliographs. I note only that a pyrheliograph, where a thermopile in a tube (placed on an equatorial mounting with clockwork) automatically follows the sun, gives nothing when the sky is clouded. On the contrary, some deviation is always given by the solarigraph, which registers not only under the influence of direct sun-rays (eliminated totally by appearance of each small cloud), but also the diffuse radiation. These deviations, produced everywhere by the sky, are sometimes very important, especially in broken or foggy weather or with a thin layer of clouds.

I mention also the extreme simplicity with which the solarimetric pile is adapted for measurement of the albedo. For this purpose it is sufficient simply to turn the receiving surface (pile under glass cover) to the ground (instead of the ordinary position directed towards the sun) in order to obtain an albedometer which enables us to measure the reflecting power of different kinds of soil, water surfaces, etc.

(*To be continued*)

Radio-sounding of the Atmosphere

In recent years the application of radio technique has led to new methods of sounding the atmosphere which have overcome a number of the drawbacks of the older methods, e.g. the limitation of pilot balloon ascents in cloudy weather, the time taken to recover ordinary meteorographs and the cost of aeroplane ascents. The new method consists of the ascent of either a simple pilot balloon or a meteorograph, combined with a small light radio transmitter, and under nearly all types of weather conditions, the transmitter can convey immediately to the ground station either the balloon's position or the air characteristics encountered at any moment, or both.

For details of the short-wave radio transmitters and receivers, and diagrams of the different apparatus used in these experiments,

the reader is referred to the original papers. The list of these papers is somewhat lengthy but the more important are given in Table 1 together with the weight of the apparatus, the wave length of the emitted signals and the method employed to signal the variations of pressure, temperature and humidity. Four methods are available, viz. :—

(1) By varying the intensity of the transmitted signal.

(2) By varying the frequency of oscillation of the transmitter.

(3) By superimposing an audio frequency on the normal frequency of transmission.

(4) By interrupting the emitted signal either simply or in a complex manner.

or a combination of any of the above.

TABLE 1.

Author.	Country.	Reference.	Method of signalling.	Weight grams.	λ metres.
		General.			
Wenstrom...	United States	*Washington D.C., Mon. Weath. Rev.*, **62**, 1934, pp. 221–6.	—	—	—
		Meteorographs.			
Bureau ...	France ...	*Météorologie, Paris*, **7**, 1931, pp. 304–20.	3 and 4	1,500	60
Duckert ...	Germany ...	*Beitr. Phys. frei. Atmos., Leipzig*, **20**, 1933, pp. 303–11.	2 and 4	—	45
Molchanoff	Russia ...	(1) *Beitr. Geophys., Leipzig*, **34**, 1931, pp. 36–56; (2) *Nature, London*, **130**, 1932, pp. 1006–7.	4	2,000	25–100
Väisälä ...	Finland ...	(1) *Helsingfors, Mitt. met. Zent-Anst.*, **29**, 1935; (2) *Helsingfors, Soc. Sci. Fenn. Comm. Phys.-Math.* **6**, No. 2, 1932.	2 and 4	400	20–23
		Pilot Balloons.			
Blair and Lewis.	United States	*New York, Proc. Inst. Radio Engrs.*, **19**, 1931, pp. 1531–60.	—	450	125
Kölzer and Möller.	Germany ...	*Met. Z., Braunschweig*, **50**, 1933, pp. 297–300.	—	740	150–200

Meteorographs.—The instruments recording pressure, temperature and humidity are caused to vary some element of the radio transmission or to interrupt the transmission in such a way that nearly

simultaneous records are conveyed to the receiver. The frequency of an oscillatory circuit is given by $1/2\pi\sqrt{LC}$ where L is the inductance and C the capacity of the circuit and in practice it is usual to vary the capacity in order to give changes in the frequency. Duckert employs this method to give continuous temperature readings, a bimetallic thermometer being linked to one plate of a condenser and the changes of capacity effected by the varying distances between the two condenser plates. The marking of pressure is given by a short break in the transmission at different pressure levels previously fixed by calibration. This is achieved by connecting two contact metal wheels in the anode circuit of the transmitter. On the rim of one of these wheels, pieces of insulated material are inserted at regular intervals. This wheel is turned by the alteration in curvature of a barometer diaphragm with changing pressure and a break in the anode current occurs whenever an insulated part of this wheel bears on the metallic rim of the other wheel. The whole apparatus is calibrated prior to the ascent. During the ascent condenser readings on the receiver (for temperature) and breaks in the transmission (for pressure) are recorded as a function of time.

In the instrument due to Moltchanoff, signals are emitted under the control of a contact which makes or breaks the anode circuit of the transmitter in accordance with the elements to be signalled. The arrangement of the control is shown diagrammatically in Fig. 1.

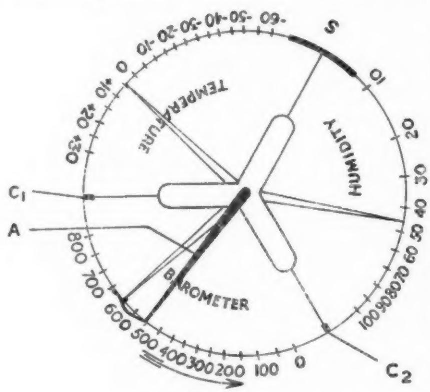


FIG. 1

Reproduced from Nature, London 130, 1932, *p.* 1007.

The contact arm A is connected to the positive plate of the anode battery and is rotated continuously by a clockwork drive making one revolution every 33 seconds. Fixed contacts S, C_1 and C_2 divide the rotation into three segments in each of which is a movable pointer which takes up a position in accordance with the particular changing meteorological element. The pressure pointer is connected to a barometer diaphragm, the thermometer pointer to a bimetallic thermometer and the humidity pointer to the usual bundle of hairs. The arm A in the course of its rotation makes fleeting contact with the top of these pointers and with the fixed contacts and as the pointers and contacts are all connected to the plate of the valve in the transmitter it will be seen that the effect is to complete the

electrical circuit at each contact and for a signal to be heard in the receiver. The time interval between signals due to the fixed contacts and the following movable pointers thus gives the instantaneous position of the latter and by calibration the pressure, temperature or humidity reading. The relatively long contact at S is for the purpose of emitting a longer signal in order to synchronise the recording cylinder at the receiver on the ground. Reception is effected automatically by an ordinary receiver followed by a picture receiver of the rotating cylinder type, similar to the Fultograph receiver. Curves having time (altitude) as abscissa and pressure, temperature and humidity as ordinates are thus directly recorded as the sounding is made and a graduated scale is available for application to the record so that the readings can be converted.

Bureau's later instrument is in many respects similar to that of Moltchanoff but he retains the system of counting time between contacts designed in his earlier instruments. Clearly Moltchanoff's arrangement depends on a uniform rotation of the clockwork driven arm A. Bureau makes his readings independent of the speed of rotation of the contact arm by inserting in the transmitter circuit a very small plate condenser. Between the plates of this condenser passes a toothed wheel turned by a system of gears so that one revolution of the contact arm always corresponds to the passage of n teeth of the wheel between the condenser plates. The passage of each tooth leads to modulation by altering the frequency of the emitted signal, so that to know the time between contacts it is necessary to count the number of periods of modulation. This is effected by passing the received signals into the coil of an oscillograph. Bureau also arranges for his instrument to transmit for the longest possible time and the circuit is therefore broken at each contact and not made as in the Moltchanoff apparatus.

One of the latest instruments is that due to Väisälä and appears capable of further development. The whole method is a comparison of capacity and an outstanding feature is the lightness of the apparatus. Each meteorological element regulates a plate condenser, the arrangement being shown in Figs. 2 and 3. The thermometer consists of a length of silver wire stretched from a curved piece of invar. From the centre of the silver wire another wire leads to the movable plate of a condenser. For the pressure element he uses an aneroid box, one side of which is fixed and the other directly attached to the movable plate of another condenser. Two fixed condensers are also included in the circuit to give signals by means of which the individual characteristics of the transmitter are eliminated. Each condenser is inserted into the oscillatory circuit once during each rotation of a master switch S as indicated in Fig. 4. so that four signals of different frequency are emitted. As the frequency of the signals through the two fixed condensers changes very slowly during the ascent, reception can be chiefly confined to the signals emitted through the condensers which vary with the pressure and temperature elements. The switch is turned by means of a light

propellor which rotates owing to the ascensional velocity of the apparatus. Condenser readings on the receiver are readily converted into pressure and temperature values by means of a calibration curve and good results appear to have been obtained. By means of this

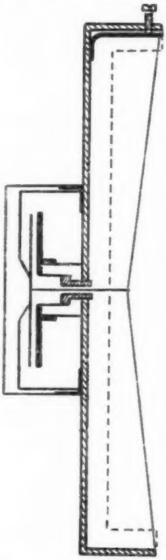


Fig. 2

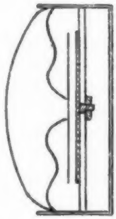


Fig. 3

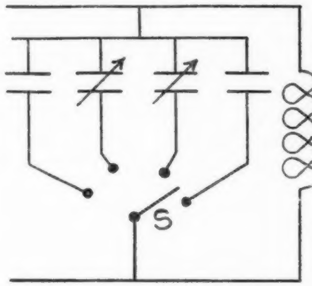


Fig. 4

Figs. 2 and 3 are reproduced from Eine neue Radiosonde. By Vilho Väisälä. *Helsingfors, Mitt. Met. Inst. Univ. No. 29.* 1935.

condenser principle, Väisälä has made a suggestion together with practical details of apparatus for the automatic recording of pressure, temperature, humidity, wind force and direction, and precipitation at an outstation and for the transmission of the readings by radio every three hours.

Pilot Balloons.—Experiments with the object of obtaining upper winds in cloudy weather have been taking place in Germany and other countries but the pioneer work was done by the United States and most of the paper by Blair and Lewis is concerned with the difficulties overcome in effecting a suitable transmitter and receiver. A transmitter is carried up by a balloon at a rate fixed by the free lift, as in the single theodolite method, and bearings are taken on it every minute by two or more directional radio receivers at the end of fixed base lines.

Balloons and Batteries.—There appears to have been little or no difficulty in finding suitable balloons to lift the somewhat heavy

apparatus. In the case of batteries (filament 1 to 5v., anode 25 to 150v.) considerable research has taken place into suitable types and also methods of thermal insulation. In particular, Väisälä in 1932 designed very light batteries of the lead-acid type, and for insulation Duckert has employed a double layer of insulating material between which is placed moistened calcium carbide.

Future Development.—In meteorographs, this will be directed chiefly towards lightness, simplicity and lower cost, and in this connexion Väisälä's apparatus is worthy of note. In this, the total weight has been reduced to 400 grams and the cost to four pounds as compared with former weights of the order 1000 to 2000 grams and cost exceeding five pounds for each instrument exclusive of balloon and hydrogen.

For pilot balloon work a three-dimensional direction finder combined with a direct reading portable apparatus is being attempted. If, in addition, the pilot-balloon transmitter serves as meteorograph transmitter, the correct height of the balloon can be ascertained instead of the estimated height (from free lift) so far employed, and then only one receiving station is required.

On the radio side improvements in suitable transmitters and receivers will undoubtedly be undertaken probably adapted to the use of very short waves, less than 20 metres, and beam systems, a field which has so far not been explored. Improvements are also to be expected in the design of suitable batteries and their thermal insulation and the possible substitution of a buzzer-transformer for the high tension battery. Enclosure of the whole transmitter in a glass vacuum tube such as in Duckert's apparatus will probably become universal if these instruments are produced commercially as they are at present in Germany.

W. H. Bigg.

The Floods of January, 1936

The autumn of 1935 was unusually wet, and in December the low lands of England were generally in a waterlogged condition. Shortly before Christmas there occurred a cold spell during which a layer of snow accumulated in the north and west. During the last few days of December heavy rain set in and this joined with the melting of the snow to cause extensive flooding. The floods began on the 27th in the Midlands and west of England, but by the 29th, Kent and Sussex were also affected and the Thames was running bank high. Further heavy rain fell on the 29th and 30th; the Thames overflowed its banks in the upper reaches and near Lechlade and Radcot thousands of acres were under water. Floods also spread widely in the Fen country. The heavy rain continued on the 31st and many main roads in the Thames valley became

impassable. The saturation of the soil caused a landslip which interrupted traffic on the main Portsmouth-London line of the Southern Railway.

The rainy weather continued during the first days of January, 1936, and the rivers rose still further. The flow of the Thames at Teddington, which had been 5,500 million gallons a day on December 29th (the normal flow in December is 2,073 million gallons), rose to 7,500 on January 1st, 8,800 on the 2nd, and 9,000 on the 3rd; on the latter day the river at Windsor was 4 ft. 3 in. above its normal level. This marked the peak of the floods, however, and with a temporary improvement in the weather the waters began to recede on the 4th. By January 7th, the flow at Teddington had again fallen to 5,500 million gallons. Further heavy rain brought a temporary rise, however, the flow of the Thames reaching 7,500 million gallons on the 10th, but after that date the weather improved again and the floods definitely abated.

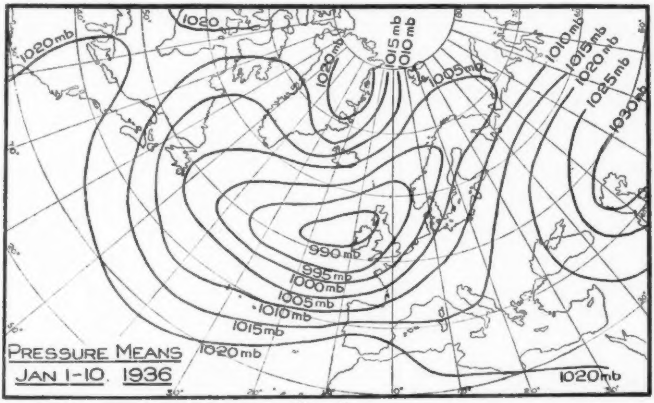


FIG. 1.

The chart of average pressures for January 1st–10th is shown in Fig. 1. A trough of low pressure extends from mid-Atlantic across the British Isles to southern Norway, and this marks the course followed by a series of deep depressions. That of the 9th–10th, which travelled along our north-western coasts, was exceptionally intense, pressure at the centre falling to 958 mb. The force of the wind displaced the Menai Bridge so that it had to be closed, while on the night of the 9th the tidal waters driven up the Severn and Wye caused these rivers to burst their banks. The resulting flood at Chepstow was the worst on record for 25 years.

The chart of pressures for December 16th–31st, closely resembles that for January 1st–10th; but on January 11th, a remarkable change set in. The belt of low pressure across the Atlantic was

interrupted by an anticyclonic ridge from Greenland to the western Mediterranean. This gave a short period of fine cold weather in Great Britain but on the 17th the depressions to the west and east joined up again and the unsettled stormy weather recommenced, beginning with widespread snow. The pressure chart for January 17th–February 2nd closely resembles that for January 1st–10th except that the lowest pressure was over the north of Scotland instead of Ireland and the rain was not so heavy. Flooding was again experienced towards the end of January, especially in the west and north of England, but the south-east was not exempt and some main roads near London were impassable. The flow of the Thames rose from 4,500 million gallons on the 29th to 6,500 on the 31st, but after February 2nd the floods again subsided.

The general rainfall over the Thames Valley above Teddington was above the average in each of the five months September, 1935, to January, 1936, the total being 21·24 in., compared with an average of 13·22 in. The rainfall of the 10 days December 23rd, 1935, to January 1st, 1936, amounted to 2·87 in. or more than the average for the whole of December (2·54 in.), that for the 6 days January 5th to 10th, 1·63 in., and of the 5 days January 27th to 31st, 1·45 in. The average for the whole of January was 4·32 in. compared with a normal of 1·94 in.

Extensive floods also occurred in France. On January 3rd, streets were under water in Toulon, the Rhone was high, the Loire had overflowed its banks and flooded Nantes, and the Seine at Paris was rising. The rivers continued to rise until the 7th and 8th ; the Seine did not approach the level of the disastrous floods of 1910, but at Nantes, that year was equalled. On the 10th the floods were definitely subsiding and after a recrudescence about the 20th there was no further mention of flood damage.

Discussions at the Meteorological Office

The subjects for discussion for the next two meetings are :—

February, 24th, 1936. *On the origin of local heat thunderstorms. Fourth paper. Investigation of the processes in the free atmosphere on days with thunderstorms.* By H. von Ficker. (Berlin, S.B. preuss. Akad. Wiss., 1934, XXIX, pp. 478-503) (in German). *Opener*—A. G. Forsdyke, Ph.D., D.I.C.

March 9th, 1936. (1) *Progressive lightning.* By B. F. J. Schonland and H. Collens. (London, Proc. Roy. Soc., A.143, 1934, pp. 654-74) and (2) *Progressive lightning II.* By B. F. J. Schonland, D. J. Malan and H. Collens (London Proc. Roy. Soc., A.152, 1935, pp. 595-625). *Opener*—C. E. Britton, B.Sc.

Royal Meteorological Society

The Annual General Meeting of this Society was held on Wednesday ,

January 15th, at 49, Cromwell Road, South Kensington, Lt.-Col. E. Gold, D.S.O., F.R.S., President in the Chair.

The Report of the Council for 1935 was read and adopted and the Council for 1936 duly elected, the new President being Dr. F. J. W. Whipple, F.Inst.P.

The Symons Gold Medal, which is awarded biennially for distinguished work done in connexion with meteorological science, was this year awarded to Professor Dr. Wilhelm Schmidt, Director of the Central Institute for Meteorology and Geodynamics, Vienna. The medal was presented to Herr von Blaas, of the Austrian Legation, who was present on behalf of Professor Schmidt.

An inscribed signet ring and a cheque were presented to Mr. A. Hampton Brown on his retirement from the position of assistant Secretary of the Society.

Lt.-Col. E. Gold delivered an address on " Wind in Britain : the Dines anemometer and some notable records during the last forty years," of which the following is an abstract :—

In 1882 J. K. Laughton described in his address the development of anemometers up to that time. He mentioned three : Lind's, Woollaston's and Adie's—elementary in character, but natural precursors of the Dines anemometer. This anemometer was developed by the late W. H. Dines in the succeeding 10 years, and has revolutionised anemometry. The instrument utilises the differences between the pressure of the wind blowing on an open tube and the suction caused by the wind blowing past holes around a vertical tube. This difference of pressure operates on a float which rises and falls as the strength of the wind changes. The float is shaped according to calculation (and not empirically) in such a way that the rise of the float is proportional to the velocity of the wind. The formulae on which the calculation is based are worked out from first principles.

A standard instrument of present day pattern is then described and the refinements which have been introduced, as the result of experience and modern knowledge of turbulent motion, explained. The methods adopted to prevent the instrument becoming choked with rime or snow and to permit of its use on board ship are also described.

A brief history is given of the introduction of the instrument and its spread over the British Isles in the last 40 years. Records from the instrument are given, showing the effect of obstacles and of topography on the wind. For example : a wind of 25 m.p.h. over the tops of the buildings at South Kensington oscillates between 5 and 45 m.p.h., while a wind of the same average strength blowing over the spit of sand known as Spurn Head, oscillates between 20 and 30 m p.h. ; the effect of a low building 25 feet away from the anemometer and 15 feet lower than the vane of the anemometer of the Lizard upset the records altogether, so that the wind went right round the compass and varied from calm to double its average speed.

Further records show winds of special character, like isolated squalls, or rising and falling like regular waves at intervals varying from ½ hour to 5 or 6 hours.

A table is given showing the highest gust recorded in each year since 1909 at places equipped with the Dines anemometer, and the highest gust recorded at each place since the inception of the records. The actual records of the severest gales at a number of representative stations illustrate the varying ways in which the gales reach their climax; they show that the severest gales at most places came with winds between S. and W. and usually after a veer of two or three points of the compass. They also indicate that the highest gusts—reaching in some cases more than 110 m.p.h.—came usually in the afternoon or at night, and practically never in the forenoon.

Finally, it is suggested that as the Dines anemometer gives a satisfactory record of the velocity and the direction of the wind, but gives no information about the sound, which is a leading characteristic and the normal method of identification of the wind, an effort should be made to obtain satisfactory sound records as a natural complement to the satisfactory visual records of the Dines anemometer.

Correspondence

To the Editor, *Meteorological Magazine*

Winter Smoke Deposit Measurement

Mr. S. C. Blacktin's remarks under the above heading in the January issue recall a similar observation, though apparently with somewhat different results, made 120 years ago by that patriarch of meteorology, Luke Howard, F.R.S. In Vol. 2, p. 320, of " The Climate of London" (2nd edn.) Howard wrote :

" Soot on Snow

I have observed that the flakes of soot which are deposited on the surface of snow, and remain there exposed to the sun's rays, disappear after some hours, leaving a cavity, the bottom of which is visible and clean. There is therefore probably a real oxidation of the carbon, after which it is dissolved in the water, in the way in which the colouring matter of cloth is destroyed in bleaching."

It would be interesting to know whether the " small galaxy of disintegrated smut " which Mr. Blacktin found surrounding the lip of each cavity does actually vanish " after some hours," under the influence of continued sunshine, as is suggested by Howard's statement.

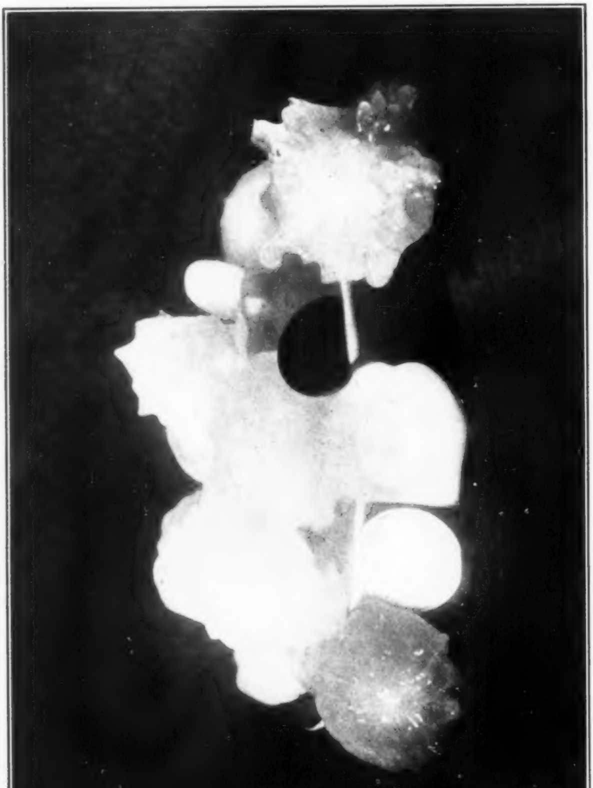
E. L. Hawke.

Caenwood, Valley Road, Rickmansworth, Herts, January 22nd, 1936.

New Meteorological Definitions

The following may perhaps be deemed a worthy addition to the examples of meteorological humour, conscious and unconscious,

facing p. 15]



Large Hailstones at Northampton

which appear in this magazine from time to time. Candidate's answer to the question " What is the difference between snow and hail ? ", set in a schoolgirls' general knowledge examination :— " Snow is frozen water gone fluffy, hail is when it has not."

E. L. HAWKE.

Caenwood, Valley Road, Rickmansworth, Herts., December 28th, 1935.

Large Hailstones at Northampton

On Sunday, September 22nd, 1935, I was awakened about 4.0 a.m. (summer time) by a bright flickering light and found this was due to lightning still too distant for thunder to be heard. The storm approached from a westerly direction through what seemed to be a greenish grey haze—quite uncanny to watch, one scarce knew what to expect.

The storm seemed to be in three adjoining sections and lightning flashes in one or other section were so frequent as to appear almost continuous. The flashes appeared to be more or less horizontal, but many with a distinctly upward tendency—there were few, if any, flashes giving the usual downward striking appearance.

As the storm approached, the thunder became one continuous rumble. Hail commenced usual size, but gradually larger stones arrived occasionally—we heard them strike a near-by corrugated iron roof. At no time was the ground more than barely covered—weather was warm so that smaller stones doubtless melted quickly. Stones up to about one inch diameter fell fairly thickly—just barely covering the ground. The larger stones, as photographed, were all found scattered over a piece of turf about 60 by 20 ft.; there must have been many more similar, but these few were picked up hurriedly —it was hailing and raining, and light by that time was poor.

As will be seen, there was considerable variation in the shape and structure of the stones. Some were more or less egg-shaped, some were convex on one side only, the other being smoother and flattened, reminding one of a small jelly fish left by the tide. In such as were smooth and had the flattened sides, one could clearly see banding, reminding one of the annular rings of a tree section. The markings were about $\frac{1}{16}$ in. apart, but were unfortunately too delicate to be shown by the crude photography.

There seemed to be a tiny nucleus covered with several layers of more or less transparent ice, thus forming a central core about $\frac{3}{16}$ in. diameter. Then followed several layers of what appeared to be snow frozen hard, forming a band about $\frac{1}{4}$ in. in thickness—then several layers of clear ice (this shows dark in the centre stone in the photograph) then more layers of the more opaque type followed by two or three layers of clear ice. Then more layers of the opaque type and the outside encrusted with further frozen snow and sometimes nodules as though smaller hailstones had attached themselves.

As suggested, there was considerable variation; for example,

one stone, a flattened oval about $1\frac{1}{4}$ in. by $\frac{3}{4}$ in., appeared to consist wholly of frozen snow, smooth outside like a large sugared almond. In some, one seemed to be able to trace five or six radial markings formed by small bubbles.

A. E. POLLARD.

22, Church Way, Weston Favell, Northampton, December 13th, 1935.

Forecasting Weather from Height of Barometer and Temperature of Wet Bulb

Investigations on this subject have recently been initiated and some results published by Lt.-Cmdr. T. R. Beatty*. The method was to analyse, for a given station and period, the occurrence of various amounts of rain following upon given values of barometer and wet bulb. A table made up in an identical way to Lt.-Cmdr. Beatty's is given in Table I. Cmdr. Beatty came to the conclusion that "low barometer and high wet bulb" was followed by most rain, and "high barometer and low wet bulb" followed by least rain. Following on this statement, one is naturally led to expect that, confining one's attention to the occurrence of no rain, the probability of a rainless period of hours is greater with "high barometer and low wet bulb" than "low barometer and high wet bulb." Mr. H. G. Lloyd†, dealing with this aspect, gave some very encouraging numerical results for the months January and February at St. Mary's, Scilly. A note by Lt.-Col. E. Gold puts Mr. Lloyd's formula as—

$$P = 15\,\frac{B - 1007}{T' - 32}$$

where P is the probability of no rain within 24 hours expressed as a percentage; B is the pressure in mb. at M.S.L. and T' is the wet bulb temperature.

Lt.-Col. Gold invites others to see if similar formulae apply elsewhere and for other months; Mr. Lloyd also states that the critical barometric pressure and the constants are likely to vary. Mr. A. H. R. Goldie** has called attention to a previous work of his†† in which good numerical relationships were obtained in correlating pressure, rainfall and wind speed at several stations, and advises the continuance of employing frequencies in this type of work. Accordingly I have analysed, through the kindness of the observer, the records of rainfall, barometric pressure and wet bulb, at Grayshott, for the ten years 1925–34.

Tables were prepared for each month similar to Lt.-Cmdr. Beatty's containing barometric pressure, wet bulb temperature, and percentage

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* *London, Meteorological Magazine* 70. 1935. pp. 34–6.

† *Ibid.* 70. 1935. pp. 162–3.

** *Ibid.* 70. 1935. p. 208.

†† *London, Geophys. Mem.* No. 53. 1931. p. 16.

number of cases of no rain, (*a*) within 12 hours, (*b*) within 24 hours. A specimen is given (Table I). Occasions of " no rain " include days of trace, and also when a measurable quantity of water was collected, known to be dew, condensed fog, etc. From these tables curves were plotted with percentage cases of no rain as ordinates, and barometric pressure as abscissae.

TABLE I. November–December, 1925–34

Barometer M.S.L.	Wet bulb °F.	No. of cases.	Percentage number of cases of		Total No. of observations.
			No rain in 12 hours.	No rain in 24 hours.	
Below 986 mb.	Above 48°	1	0	0	19
	44°–48°	7	0	0	
	39°–43°	9	22	11	
	34°–38°	2	0	0	
	Below 34°	0	—	—	
986–995 mb.	Above 48°	6	17	17	37
	44°–48°	16	19	19	
	39°–43°	10	40	20	
	34°–38°	5	20	20	
	Below 34°	0	—	—	
996–1005 mb.	Above 48°	11	9	9	103
	44°–48°	33	18	3	
	39°–43°	31	32	16	
	34°–38°	23	65	61	
	Below 34°	5	20	0	
1006–1015 mb.	Above 48°	10	0	0	149
	44°–48°	28	29	14	
	39°–43°	39	61	31	
	34°–38°	56	55	47	
	Below 34°	16	100	63	
1016–1025 mb.	Above 48°	16	44	31	159
	44°–48°	27	67	41	
	39°–43°	41	63	46	
	34°–38°	40	63	57	
	Below 34°	35	76	57	
1026–1035 mb.	44°–48°	20	70	60	107
	39°–43°	36	67	58	
	34°–38°	26	81	61	
	Below 34°	25	88	88	
Above 1035 mb.	44°–48°	6	100	100	36
	39°–43°	9	100	100	
	34°–38°	9	100	100	
	Below 34°	12	100	83	
		610			610

The results are as follows :—

Taking individual months, no simple relationships were discovered. The probability P of no rain in the next 24 hours, expressed as a percentage for January, is—

$$P = \frac{93\,[B - 1003]}{T' + 4}$$

and this formula has to be replaced for wet bulb temperature below 34° and barometer below 1010 mb. by—

$$P = \frac{22}{9}\,[1010 - B] + 16$$

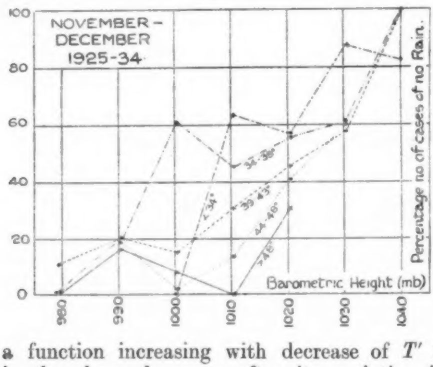
For February—

$$P = \frac{400\,[B - 1003]}{3T' + 16}$$

can be used for $T' > 38°$ but fails to hold for pressure below 1010 mb.

On proceeding, relationships more awkward were found for other months; and the same was found for P meaning no rain in 12 hours. It was suspected that the irregular results were due to too few data, so pairs of months were next tried, and the process repeated.

Fig. I is the result of the plotting of the percentage of no rain for 24 hours in Table I. Relationships were obtained from these graphs where possible, of the same form as Mr. Lloyd's, but in deriving these I came to the following conclusions :—



(1) It is often impossible to find a "critical barometric pressure" in the monthly or two-monthly curves (*see* Fig. 1).

(2) If $P = a\,[B - K]$, where K=critical barometric pressure, and a is a constant; $a = f(T')$, a function increasing with decrease of T' in Mr. Lloyd's work; in the above, however, often its variation is quite irregular, and in the summer, it tends to increase with increase of T'; i.e. "high barometer and low wet bulb" do not give the greatest probability of no rain in a given period of hours.

The above results refer to an inland high level station. They are offered as a comparison with St. Mary's, Scilly. It is desirable that such data should be found at other stations. The whole usefulness of forecasts from barometer and wet bulb is that of simplicity ;

it has been shown that for Grayshott no such simple relations exist; this may be due to too short a period used for computation; to a peculiar local climatic feature; or to the fact that simple relations cannot in general be obtained between the elements concerned. It is a matter for further work to clear up.

S. E. ASHMORE.

Llannerch Gardens, St. Asaph, Flintshire, December 1st, 1935.

Virga and Secondary Rainbows

On Saturday, November 23rd, 1935, at 12h. 40m. G.M.T. an interesting rainbow phenomenon was observed. The eastern half of a patch of altocumulus (medium cloud type 4) was covered by three spectra, almost horizontal, for about 15 seconds, while a fourth was also in evidence for 5 seconds. The colours were exceptionally well defined with red at the lower limit and violet on the outside. As the altocumulus moved westwards (nephoscope reading 80°, 36 m.p.h.) the cloud became very narrow and only one spectrum was then observed.

The portion of the cloud covered by the spectra had a "smoking" appearance which obviously indicated wisps of rain, or virga, and the spectra observed were presumably secondary rainbows although there was no evidence of a primary bow. At the time the clouds present were large cumulus 7/10 and altocumulus 1/10 while a shallow layer of haze, about 50 feet deep, covered the countryside. Horizontal visibility in the haze was only 1,500 to 2,000 yards but looking up at a slight angle was as much as 4 to 6 miles.

WILLIAM D. FLOWER.

Lyndene, The Bache Estate, Liverpool Road, Chester, November 26th, 1935.

Fog-bow at Sealand

A good example of this phenomenon was witnessed on November 24th, 1935. At about 9h. 15m. a white semicircle of light, having a diameter of 38° and an elevation at the top of 25° (approx.), was observed in a direction opposed to the sun, and at its centre there was a very brilliant white patch. The sky was clear in the zenith but cirrus clouds were plentiful below about 40° and increasing. There was a thick ground mist with visibility only 1,000 yards. The temperature in the screen was 27° F. and on the ground about 25° F. The bow gradually disappeared as the sun rose above the layer of mist.

GEO. R. READ.

Roker, Station Road, Gt. Saughall, near Chester, November 26th, 1935.

NOTES AND QUERIES

The Formation of Cloud by Aeroplanes, September 3rd, 1935

On the afternoon of September 3rd, 1935, "cloud-streaks" of unusual length and persistence were formed by two aeroplanes, and were

observed from several places in the south of England. One aeroplane was flying from the Isle of Wight to South Farnborough and back, and the cloud was formed during sustained level flight at a height given by the aneroid as 29,000 ft.; the other was flying over Tangmere, near Chichester, and the cloud was formed at a level of 31,000 ft.

Mr. C. J. P. Cave, who was at Chichester Harbour, describes the occurrence as "the best example of 'aeroplane cloud' I have ever seen . . . . The time I first noticed it was about 3 p.m. summer time but the formation had been going on some time before that and it continued for some time after. The clouds remained visible for at least two hours, though after some time they became exactly like cirrus clouds, of which there were others about. It seemed to me that part of the formation took place at the cirrus level, and some of it, the later part, may have been a good deal higher than the level at which cirrus was forming."

Mr. H. W. L. Absalom, who saw the occurrence from Hayling Island, adds that there were two streaks of cloud, both in a general east to west azimuth, though the one was situated rather more east-north-east to west-south-west than the other.

At Tangmere the cloud was formed by an aeroplane flying in a north-easterly direction, but at one point the pilot made a complete turn and a complete ring of cloud was formed. The formation of this cloud ceased at 3.14 p.m. B.S.T. When first formed it was about 80 ft. wide, and in a quarter of an hour it had expanded to four times its original width, but it never widened beyond two solar diameters. The aeroplane itself could not be seen at first, but when the pilot turned against the sun there appeared to be a short gap, perhaps 40 ft. between the aircraft and the start of the cloud. The streak drifted slowly eastwards and was still visible at 5.30 p.m. The sky was blue overhead when the cloud was formed, but later it became mingled with thin cirrus and cirrocumulus clouds. The total length was estimated at between eight and nine miles. A second streak which may have been formed by the same machine earlier, was seen at the same time further to the north-west.

Conditions for the formation of clouds by aeroplanes are generally limited to a comparatively thin layer of air, of the order of 1,000 ft. in thickness and at a height of about 30,000 ft., though sometimes much less. On this occasion a solar halo was observed at 12.30 p.m., B.S.T., ; afterwards the sky cleared considerably but at the time the cloud was formed there were some wisps of cirrus, with about 3 tenths of cirrocumulus and 4 tenths of detached cumulus. The pilot of one machine noticed the existence of very fine ice specks at one point, and his goggles were frosted. At 3 p.m. the temperature at ground level was: dry bulb 66° F., wet bulb 61° F. A pilot balloon ascent at 7 a.m. showed a steady wind of 24–32 m.p.h. from WSW. up to 16,000 ft.

REVIEW

India Meteorological Department, Scientific Notes Vol. VI, No. 64.—*Some observations on the thermal structure of cumuliform cloud.* By Flt. Lt. R. G. Veryard, B.Sc.

The author made arrangements for pilots at Risalpur, Peshawar and Kohat to make observations of dry and wet bulb temperature inside and outside cumuliform clouds, as opportunities arose, during 1932 and 1933. This valuable paper gives full details of 34 cases, and a discussion of the results. Some personal observations on a hill summit are included.

The cloud was mainly colder than its environment on 19 occasions, mainly warmer on 10, and in the remaining 5 was about the same, or partly warmer and partly colder.

The cases which require explanation are those when the air in the clouds is denser than its environment, after the influence of water vapour has been allowed for. There are only two possible explanations. One is that the cloud is supported from below by air which is lighter than its environment. This must normally require a lapse-rate below the cloud at least up to the dry adiabatic rate, and also an absence of appreciable wind shearing. Veryard's observations reveal some cases of super-adiabatic lapse-rate below the clouds, but in these cases the cloud was nearly always warmer than its environment. The other explanation is that the cloud is not in equilibrium, and that dynamical factors are involved. In many cases the cloud base was about 7,000 or 8,000 ft. above the aerodrome level, and the lapse-rate through most or all of this range of height was not up to the dry adiabatic rate. When there is shear in the horizontal movement any vertical movement would introduce disturbance, with a dynamical element. The hilly nature of the country near the North-west Frontier must be taken into account, but actually the relative coldness of the clouds is frequent in England also. Probably sometimes a rising mass of air is carried by its momentum temporarily past its equilibrium position. Veryard notes that in 14 cases the cloud was dissolving, and that in 13 of these cases the air in the cloud was colder than its environment.

The paper brings out the variety of conditions prevailing in cumuliform clouds, and shows that in some cases it is difficult to avoid a partly dynamical explanation.

C. K. M. Douglas.

BOOK RECEIVED

Deutsches Meteorologisches Jahrbuch für Bayern, 1934. The Bavarian Meteorological Year book for 1934 contains as usual a number of valuable appendices among which may be mentioned "Der Gang des Winters auf der Zugspitze" by A. Schmauss and "Feldstärke-und Schwundmessungen im Rundfunkwellenbereich auf dem Zugspitzgipfel" by A. Agricola.

NEWS IN BRIEF

A solar-radiation station was established by the Smithsonian Institution at Mount St. Katherine, Sinai Peninsula, in the summer of 1933, and regular observations begun in December, 1933. A description of the station and a comparison of the results obtained there and at Montezuma, Chile, during 1934 and the early part of 1935, are given in "Mount St. Katherine: An excellent solar-radiation station", by C. G. Abbot, Smithsonian Miscellaneous Collections, Vol. 94, No. 12.

The Senate of the University of London has conferred the degree of D.Sc. in Physics on Mr. A. W. Lee of Kew Observatory.

The staff of the Meteorological Office, Shoeburyness, held their fifteenth Annual Dinner at the Palace Hotel, Southend-on-Sea, on Saturday, February 8th. There was a record attendance of past and present members of the staff including several from other Government Departments. The Superintendent for Army Services, Mr. J. S. Dines, M.A., was present and the two former Superintendents, Professor D. Brunt, M.A. and Mr. F. Entwistle, B.Sc., also attended the function.

The Weather of January, 1936

Pressure was below normal over Europe, the Mediterranean, the North Atlantic, most of the United States and Alaska, the greatest deficits being 18·0 mb. at Valentia and 3·0 mb. near New Orleans. Pressure was above normal over north-west Asia, Spitsbergen, Iceland, Greenland and most of Canada, the greatest excesses being 9·1 mb. at Waigatz, 13·8 mb. at Isafjord and 6·6 mb. near Lake Athabaska. Temperature was above normal generally over Spitsbergen and western and central Europe (except in north Sweden) and precipitation above normal except at Spitsbergen. Precipitation was twice the normal on the average in Sweden.

The outstanding features of the weather of the British Isles during January were the mild wet conditions during the first ten days and the low temperatures experienced in the middle of the month. Rainfall totals were mostly above normal, records being exceeded at a few places while sunshine was mainly below normal in England and Ireland but above normal in Scotland. From the 1st to the 10th, depressions passing in a north-easterly direction across the country gave generally wet mild conditions except during the 3rd–4th, when fair weather prevailed as a wedge of high pressure extending from Greenland crossed the country; 6·7 hrs. bright sunshine were experienced at the Scilly Isles on the 4th and 5·7 hrs. at Valentia on the 3rd. Mist or fog was prevalent on the 3rd and local on the 8th. Rain occurred on most days followed by floods* in

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* *See* p. 10.

some areas, and was heaviest, generally on the 9th, when 2·28 in. fell at Borrowdale (Cumberland) and 2·09 in. at Trecastle (Brecon), and in Ireland and the Lake district on the 4th, when 2·60 in. fell at Borrowdale. Gales occurred in the south-west and west on the 5th, and in the north on the 6th, a gust of 84 m.p.h. being recorded at Scilly on the 5th, while on the 9th–10th still stronger winds prevailed in south-west England, a gust of 100 m.p.h., being registered at Pembroke on the 9th. Temperature was mainly high during this period especially on the 9th and 10th, when 58° F. was reached at Bath and Westminster on the 9th. Thunderstorms occurred locally in north England on the 9th. In the rear of the deep depression of the 9th and 10th cold N. to NW. winds spread across the country and temperature fell considerably while snow showers were general in Scotland. Gales occurred in north Scotland on the 11th. From the 12th–15th the country came under the influence of an anticyclone and cold quiet weather was experienced with local wintry showers but many bright periods especially in the north, 6·2 hrs. bright sunshine were recorded at Leuchars, Abbotsinch and Birmingham on the 13th. Mist or fog were, however, prevalent in England during this time. From the 16th to 19th, a complex low pressure system passed across the country and cold northerly winds with very low temperatures and much snow and sleet prevailed. Snow was lying to a depth of 2 to 3½ in. in many parts of the north on the 17th and 18th, and the lowest day temperatures of the month were recorded on the 19th when 21° F. and 24° F. were the maxima at Catterick and Eskdalemuir respectively. Screen minima fell to 8° F. at Dalwhinnie on the 20th and 9° F. at Manchester on the 19th, and ground minima to 6° F. at Rhayader on the 13th and 19th, and at Auchincruive on the 17th. Much sun occurred at times in the north, e.g., 7·2 hrs. at Leuchars on the 18th. From the 19th to 31st depressions passed across the country and temperature rose somewhat in the south but continued low in the north until about the 25th. Snow and sleet fell generally over the country between the 19th and 25th, even as far south as Falmouth and lay to a depth of 5 to 7 in. in parts of the north. Gales occurred in the extreme north on the 21st. From the 26th to 31st conditions were generally mild and unsettled with rain most days and strong winds at times. There were many bright intervals especially on the 23rd and 26th, but mist or fog occurred locally. Thunderstorms were reported locally on the 22nd and 28th. The distribution of bright sunshine for the month was as follows :—

	Total (hrs.)	Diff. from normal (hrs.)		Total (hrs.)	Diff. from normal (hrs.)
Stornoway ...	43	+16	Chester ...	42	− 9
Aberdeen ...	53	+ 9	Ross-on-Wye ...	35	−17
Dublin	55	+ 1	Falmouth ...	56	− 3
Birr Castle ...	39	− 9	Gorleston ...	42	−13
Valentia... ...	34	− 8	Kew	30	−14

Miscellaneous notes on weather abroad culled from various sources

Floods and storms caused much damage in Portugal early in the month. A landslide due to heavy rain killed two people on the Paris–Mantes road on the 1st. Further heavy rain occurred in France during the first half of the month followed by severe floods.* The Föhn wind was blowing in Switzerland on the 2nd; rain fell up to the 4,000 feet level, but heavy snow above 6,000 feet. On the 5th there was a change to generally wintry conditions, which lasted until the 9th when the Föhn wind came again and temperature rose generally. A thunderstorm accompanied by a whirlwind occurred in the neighbourhood of Dusseldorf and in Westphalia on the 10th, when two people were killed and considerable damage done to property. Temperature fell below freezing point generally in Switzerland on the 15th. Violent whirlwinds accompanied a storm over Florence on the 20th. The port of Seville was opened on the 21st but closed again on the 24th, as the water was rising. Floods were continuing on the river Douro on the 25th. Navigation closed at Vasa on the 25th. (*The Times*, January 2nd–27th.)

Rain fell in parts of the northern Transvaal early in the month and later reports of torrential rain came from those areas which had suffered very severely from drought; dams were broken by the floods and roads washed away. Johannesburg experienced a sudden change from a heat wave to wintry conditions about the 20th. Heavy rains occurred in north Abyssinia between about the 19th and 24th and in south Abyssinia later in the month. (*The Times*, January 15th–February 2nd.)

Exceptionally cold weather was experienced in Afghanistan and the North-West Frontier with much snow early in the month. (*The Times*, January 7th.)

Extensive, heavy and beneficial rains fell in the pastoral and cattle districts of South Australia from the 1st to 9th, and floods occurred over large areas. The rainfall for the month was above normal generally in Western Australia, Tasmania and parts of Queensland. Calm clear weather was experienced by the Discovery II on her three days voyage from Dunedin through the ice pack to the Bay of Whales. (Cable and *The Times*, January 6th–18th.)

A blizzard swept across Wyoming on the 9th. On the 19th, bitterly cold weather accompanied by tornadoes resulted in the death of 17 persons in Georgia, Alabama and Florida and much damage to property while in the north-eastern States, gales accompanied by snowstorms occurred and seven people died. The intensely cold weather experienced in the central parts of North America during the middle of the month spread also to the eastern areas on the 23rd, with temperatures below zero. Blizzards occurred in many parts and the south from Texas to the Atlantic, except the coast and Florida, was covered with snow. The American falls at Niagara froze solid about the 29th; 75 people died from

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* *See* p. 12.

the cold. The Nantucket lightship broke adrift during a severe gale on the 23rd. In the United States temperature was above normal during the first half of the month becoming considerably below normal towards the end except along the western coasts, while rainfall was mainly in excess early in the month becoming generally deficient towards the end. Frequent rains occurred in the Argentine early in the month. (*The Times*, January 11th–31st and *Washington, D.C., U.S. Dept., Agric., Weekly Weather and Crop Bulletin.*)

Daily Readings at Kew Observatory, January, 1936

Date	Pressure, M.S.L. 13h.	Wind, Dir., Force 13h.	Temp.		Rel. Hum. 13h.	Rain.	Sun.	REMARKS. (see vol. 69, 1934, p. 1).
			Min.	Max.				
	mb.		°F.	°F.	%	in.	hrs.	[19h.
1	987·8	S.2	47	48	92	0·40	0·0	r–r_0 4h.–6h. & 10h.–
2	987·7	SW.2	45	47	94	0·04	0·2	r–r_0 5h.–7h. & 11h.–
3	992·0	NW.1	37	40	89	—	0·4	f 9h.–15h. [15h.
4	1013·5	WSW.2	37	46	83	—	0·9	
5	1004·2	SSE.4	36	45	78	0·02	0·0	r_0 19h.–20h.
6	990·2	S.3	43	47	83	0·16	0·9	r–r_0 5h.–11h., 18h. &
7	989·7	SW.1	42	45	94	0·28	0·7	r–r_0 3h.–14h. [24h.
8	999·6	S.3	41	48	91	0·13	0·0	r–r_0 12h.–24h.
9	1000·3	SSW.4	47	54	89	0·28	0·0	r–r_0 0h.–1h. & 11h.–
10	998·6	SW.5	49	55	72	0·25	1·8	rR 1h.–4h. [19h.
11	1021·8	W.3	44	46	58	—	0·4	
12	1024·4	SW.1	38	39	85	—	0·0	fF 13h.–24h.
13	1023·2	W.2	29	41	73	—	0·0	f 0h.–13h., fx 18h.–
14	1027·1	Calm	26	31	94	trace	0·0	fFx all day. [24h.
15	1020·9	ESE.2	23	36	83	trace	0·0	Fxf till 18h.
16	1002·0	NE.2	33	36	·91	0·35	0·0	rsf 11h.–20h., s 20h.–
17	996·6	NNW.4	33	36	73	0·11	2·0	s 0h.–3h. [24h.
18	995·5	W.1	27	37	90	0·20	2·4	r 4h.–7h., s 7h.–10h.
19	994·3	E.3	26	38	87	0·08	0·0	s_0 8h., r–r_0 18h.–24h.
20	980·6	SSW.5	37	47	74	0·11	1·5	r–r_0 0h.–5h.
21	989·2	W.5	36	43	58	—	6·1	
22	999·7	SW.2	30	40	78	0·12	0·6	r–rs 16h.–18h.
23	1009·3	WSW.2	32	42	82	trace	3·2	x early, r_0 23h.–24h.
24	1002·0	ESE.3	35	44	73	0·08	0·7	r_0 0h.–3h. & 17h.–24h.
25	992·4	E.3	38	49	93	0·02	0·0	r_0 0h.–6h. & 15h.–16h.
26	996·2	WSW.3	45	47	71	0·07	5·1	r_0–r 2h.–7h. [19h.
27	994·4	SSW.3	38	47	91	0·09	0·0	x early, r 10h.–12h. &
28	996·6	WSW.4	44	51	64	0·70	1·1	r–r_0 6h.–9h., 19h.–24h.
29	982·9	SW.1	45	50	91	0·03	0·1	r 0h.–1h., 9h.–10h.
30	1000·7	SW.3	38	50	80	0·06	1·5	r–r_0 3h.–4h., 16h.–17h.
31	991·0	SW.2	46	53	96	0·32	0·1	rR 12h.–15h.
*	1000·1	—	38	44	82	3·91	1·0	* Means or totals.

General Rainfall for January, 1936.

England and Wales ...	178	per cent. of the average 1881–1915.
Scotland	140	
Ireland	148	
British Isles	163	

Rainfall : January, 1936 : England and Wales

Co.	Station.	In.	Per cent of Av.	Co.	Station.	In.	Per cent of Av.
Lond .	Camden Square..........	4·02	216	*Leics* .	Thornton Reservoir ...	3·75	189
Sur .	Reigate, Wray Pk. Rd..	5·71	238	,, .	Belvoir Castle............	3·48	196
Kent .	Tenterden, Ashenden...	4·68	218	*Rut* .	Ridlington	3·81	206
,, .	Folkestone, Boro. San.	4·87	...	*Lincs* .	Boston, Skirbeck.........	3·02	186
,, .	Eden'bdg., Falconhurst	5·38	220	,, .	Cranwell Aerodrome...	3·30	192
,, .	Sevenoaks, Speldhurst.	5·42	...	,, .	Skegness, Marine Gdns.	2·99	173
Sus .	Compton, Compton Ho.	6·29	198	,, .	Louth, Westgate.........	2·89	133
,, .	Patching Farm..........	4·47	172	,, .	Brigg, Wrawby St.......	3·25	...
,, .	Eastbourne, Wil. Sq....	4·76	181	*Notts* .	Worksop, Hodsock......	3·45	195
,, .	Heathfield, Barklye....	6·12	249	*Derby*.	Derby, L. M. & S. Rly.	3·13	157
Hants.	Ventnor, Roy.Nat.Hos.	5·25	204	,, .	Buxton, Terr. Slopes...	7·23	162
,, .	Fordingbridge, Oaklnds	5·95	215	*Ches* .	Runcorn, Weston Pt....	4·79	202
,, .	Ovington Rectory.......	6·86	254	*Lancs*.	Manchester, Whit. Pk.	3·59	143
,, .	Sherborne St. John......	5·00	214	,, .	Stonyhurst College......	4·01	94
Herts .	Royston, Therfield Rec.	3·52	203	,, .	Southport, Bedford Pk.	4·14	162
Bucks.	Slough, Upton............	4·61	248	,, .	Lancaster, Greg Obsy.	4·27	122
,, .	H. Wycombe, Flackwell	4·22	194	*Yorks*.	Wath-upon-Dearne......	2·81	146
Oxf .	Oxford, Mag. College...	2·59	150	,, .	Wakefield,Clarence Pk.	3.07	160
Nor .	Wellingboro, Swanspool	3·59	194	,, .	Oughtershaw Hall.......	6·33	...
,, .	Oundle	3·20	...	,, .	Wetherby, Ribston H..	4·31	209
Beds .	Woburn, Exptl. Farm...	3·20	187	,, .	Hull, Pearson Park......	2·81	156
Cam .	Cambridge, Bot. Gdns.	2·72	181	,, .	Holme-on-Spalding......	3·44	182
Essex .	Chelmsford,County Gdns	4·19	274	,, .	West Witton, Ivy Ho.	4·98	157
,, .	Lexden Hill House......	4·22	...	,, .	Felixkirk, Mt. St. John.	3·68	184
Suff .	Haughley House.........	3·03	...	,, .	York, Museum Gdns....	3·31	187
,, .	Campsea Ashe...........	...	...	,, .	Pickering, Hungate......	4·31	206
,, .	Lowestoft Sec. School...	2·66	159	,, .	Scarborough...............	3·97	199
,, .	Bury St. Ed., WestleyH.	3·64	203	,, .	Middlesbrough............	3·04	190
Norf. .	Wells, Holkham Hall...	2·64	182	,, .	Baldersdale, Hury Res.	5·08	156
Wilts .	Calne, Castle Walk......	3·79	...	*Durh* .	Ushaw College............	4·26	208
,, .	Porton, W.D. Exp'l. Stn	4·30	187	*Nor* .	Newcastle, D. & D. Inst.	3·26	176
Dor .	Evershot, Melbury Ho.	6·72	193	,, .	Bellingham, Highgreen	5·13	179
,, .	Weymouth, Westham.	4·50	186	,, .	Lilburn Tower Gdns....	4·87	235
,, .	Shaftesbury,Abbey Ho.	3·79	146	*Cumb*.	Carlisle, Scaleby Hall...	3·35	135
Devon.	Plymouth, The Hoe....	6·57	197	,, .	Borrowdale, Seathwaite	16·00	127
,, .	Holne, Church Pk. Cott.	12·43	201	,, .	Borrowdale, Moraine...	13·46	134
,, .	Teignmouth, Den Gdns.	6·63	227	,, .	Keswick, High Hill......	6·72	133
,, .	Cullompton	4·92	152	*West* .	Appleby, Castle Bank...	4·80	150
,, .	Sidmouth, U.D.C........	5·21	...	*Mon* .	Abergavenny, Larchf'd	6·87	203
,, .	Barnstaple, N. Dev.Ath	4·02	123	*Glam* .	Ystalyfera, Wern Ho....	7·64	121
,, .	Dartm'r,Cranmere Pool	10·40	...	,, .	Cardiff, Ely P. Stn.......	4·15	110
,, .	Okehampton, Uplands.	8·52	167	,, .	Treherbert, Tynywaun.	11·86	...
Corn .	Redruth, Trewirgie......	7·35	174	*Carm* .	Carmarthen, The Friary	...	...
,, .	Penzance, Morrab Gdns.	6·59	174	*Pemb* .	St. Ann's Hd, C. Gd. Stn.	5·73	173
,, .	St. Austell, Trevarna...	8·50	199	*Card* .	Aberystwyth	4·62	...
Soms .	Chewton Mendip.........	5·17	135	*Rad* .	BirmW.W.Tyrmynydd	9·53	151
,, .	Long Ashton............	3·53	123	*Mont* .	Lake Vyrnwy	8·86	157
,, .	Street, Millfield..........	3·88	...	*Flint* .	Sealand Aerodrome......	6·10	...
Glos .	Blockley	3·77	...	*Mer* .	Dolgelley, Bontddu......	7·69	135
,, .	Cirencester, Gwynfa....	3·93	157	*Carn* .	Llandudno	3·90	162
Here .	Ross, Birchlea............	4·39	182	,, .	Snowdon, L. Llydaw 9..	18·18	...
Salop.	Church Stretton.........	4·13	163	*Ang* .	Holyhead, Salt Island...	4·85	167
,, .	Shifnal, Hatton Grange	3·06	158	,, .	Lligwy	4·75	...
Staffs.	Market Drayt'n, Old Sp.	3·23	147	*Isle of Man*			
Worc .	Ombersley, Holt Lock.	3·23	168		Douglas, Boro' Cem....	6·44	192
War .	Alcester, Ragley Hall...	2·96	153	*Guernsey*			
,, .	Birminghm, Edgbaston	3·54	175		St. PeterP't.Grange Rd.	6·91	236

Rainfall: January, 1936: Scotland and Ireland

Co.	Station.	In.	Per cent of Av.	Co.	Station.	In.	Per cent of Av.
Wig	Pt. William, Monreith.	5·16	157	*Suth*	Melvich	4·93	149
,,	New Luce School	5·51	136	,,	Loch More, Achfary	6·19	85
Kirk	Dalry, Glendarroch	7·75	139	*Caith*	Wick	4·06	165
,,	Carsphairn, Shiel	9·63	131	*Ork*	Deerness	4·76	138
Dumf.	Dumfries, Crichton R.I.	5·21	172	*Shet*	Lerwick	3·64	85
,,	Eskdalemuir Obs	8·08	150	*Cork*	Caheragh Rectory	...	...
Roxb	Hawick, Wolfelee	5·41	169	,,	Dunmanway Rectory	7·82	125
Selk	Ettrick Manse	7·22	153	,,	Cork, University Coll	7·51	186
Peeb	West Linton	4·46	...	,,	Ballinacurra	6·65	167
Berw	Marchmont House	4·33	192	,,	Mallow, Longueville	6·93	178
E.Lot	North Berwick Res	...	...	*Kerry*	Valentia Obsy	8·79	160
Midl	Edinburgh, Blackfd. H.	3·59	204	,,	Gearhameen	12·20	120
Lan	Auchtyfardle	4·21	...	,,	Bally McElligott Rec	6·30	...
Ayr	Kilmarnock, Kay Pk	4·17	...	,,	Darrynane Abbey	8·33	166
,,	Girvan, Pinmore	5·95	126	*Wat*	Waterford, Gortmore	6·80	187
Renf	Glasgow, Queen's Pk	4·69	140	*Tip*	Nenagh, Cas. Lough	6·91	175
,,	Greenock, Prospect H.	6·55	96	,,	Roscrea, Timoney Park	4·27	...
Bute	Rothesay, Ardencraig	4·50	...	,,	Cashel, Ballinamona	5·04	135
,,	Dougarie Lodge	4·02	...	*Lim*	Foynes, Coolnanes	4·65	123
Arg	Ardgour House	3·69	...	,,	Castleconnel Rec	4·07	...
,,	Glen Etive	...	...	*Clare*	Inagh, Mount Callan	6·99	...
,,	Oban	3·06	...	,,	Broadford, Hurdlest'n.	3·59	...
,,	Poltalloch	4·40	87	*Wexf*	Gorey, Courtown Ho	7·44	238
,,	Inveraray Castle	6·05	74	*Wick*	Rathnew, Clonmannon.	6·94	...
,,	Islay, Eallabus	4·53	97	*Carl*	Hacketstown Rectory	5·39	152
,,	Mull, Benmore	...	...	*Leix*	Blandsfort House	4·66	142
,,	Tiree	...	...	*Offaly*	Birr Castle	5·96	211
Kinr	Loch Leven Sluice	4·85	154	*Dublin*	Dublin, FitzWm. Sq	2·78	121
Perth	Loch Dhu	...	...	,,	Balbriggan, Ardgillan	4·24	185
,,	Balquhidder, Stronvar.	...	...	*Meath*	Beauparc, St. Cloud	4·50	...
,,	Crieff, Strathearn Hyd.	4·98	124	,,	Kells, Headfort	3·74	119
,,	Blair Castle Gardens	2·94	88	*W.M*	Moate, Coolatore	4·14	...
Angus	Kettins School	5·17	197	,,	Mullingar, Belvedere	4·58	143
,,	Pearsie House	4·02	...	*Long*	Castle Forbes Gdns	4·33	130
,,	Montrose, Sunnyside	4·30	216	*Gal*	Galway, Grammar Sch.	4·71	...
Aber	Braemar, Bank	4·26	134	,,	Ballynahinch Castle	6·80	109
,,	Logie Coldstone Sch	3·53	160	,,	Ahascragh, Clonbrock.	5·27	136
,,	Aberdeen, Observatory.	4·44	204	*Mayo*	Blacksod Point	4·04	79
,,	Fyvie Castle	4·83	204	,,	Mallaranny	7·82	...
Moray	Gordon Castle	4·07	202	,,	Westport House	5·67	122
,,	Grantown-on-Spey	2·84	117	,,	Delphi Lodge	10·67	108
Nairn	Nairn	2·57	129	*Sligo*	Markree Castle	4·28	110
Inv's	Ben Alder Lodge	3·04	...	*Cavan*	Crossdoney, Kevit Cas.	4·83	...
,,	Kingussie, The Birches.	2·82	...	*Ferm*	Enniskillen, Portora	4·11	...
,,	Inverness, Culduthel R.	2·78	...	*Arm*	Armagh Obsy	3·29	131
,,	Loch Quoich, Loan	4·97	...	*Down*	Fofanny Reservoir	11·91	...
,,	Glenquoich	...	...	,,	Seaforde	6·03	191
,,	Arisaig, Faire-na-Sguir.	...	...	,,	Donaghadee, C. G. Stn.	4·88	192
,,	Fort William, Glasdrum	3·18	...	,,	Banbridge, Milltown	4·19	187
,,	Skye, Dunvegan	2·94	...	*Antr*	Belfast, Cavehill Rd	5·90	...
,,	Barra, Skallary	2·48	...	,,	Aldergrove Aerodrome.	4·28	156
R&C	Alness, Ardross Castle.	4·87	128	,,	Ballymena, Harryville.	5·26	142
,,	Ullapool	2·63	57	*Lon*	Garvagh, Moneydig	4·65	...
,,	Achnashellach	...	...	,,	Londonderry, Creggan.	4·05	113
,,	Stornoway	2·85	55	*Tyr*	Omagh, Edenfel	4·58	129
Suth	Lairg	5·40	165	*Don*	Malin Head	4·45	...
,,	Tongue	5·62	143	,,	Killybegs, Rockmount.	3·05	...

Climatological Table for the British Empire, August, 1935

STATIONS.	PRESSURE. Mean of Day M.S.L. mb.	PRESSURE. Diff. from Normal. mb.	TEMPERATURE. Absolute. Max. °F.	TEMPERATURE. Absolute. Min. °F.	TEMPERATURE. Mean Values. Max. °F.	TEMPERATURE. Mean Values. Min. °F.	TEMPERATURE. Mean Values. ½ Max. and Min. °F.	TEMPERATURE. Mean Values. Diff. from Normal °F.	TEMPERATURE. Mean. Wet Bulb. °F.	Relative Humidity. %	Mean Cloud Am'nt 0–10	PRECIPITATION. Am'nt. in.	PRECIPITATION. Diff. from Normal. in.	PRECIPITATION. Days.	BRIGHT SUNSHINE. Hours per day.	BRIGHT SUNSHINE. Per-centage of possible.
London, Kew Obsy....	1015·9	+ 0·6	84	44	73·2	54·5	63·9	+ 2·3	56·4	83	5·6	1·99	− 0·25	7	6·2	43
Gibraltar..................	1014·2	− 2·3	96	64	83·0	70·3	76·7	+ 0·7	67·3	79	4·1	0·06	− 0·06	2	...	...
Malta......................	1015·0	+ 0·2	91	70	84·2	74·4	79·3	+ 0·2	72·6	74	2·8	0·01	− 0·13	1	11·2	83
St. Helena	1016·1	+ 0·2	63	52	60·2	54·2	57·2	− 0·2	54·8	92	8·7	1·44	...	15	...	...
Freetown, Sierra Leone	1013·5	+ 0·8	85	67	81·7	71·5	76·6	− 1·3	74·5	90	9·4	52·65	+ 16·08	24	...	...
Lagos, Nigeria	1013·3	+ 0·3	84	72	81·9	73·5	77·7	− 0·2	73·8	86	8·9	0·42	− 2·22	6	4·6	37
Kaduna, Nigeria	1009·2	...	88	65	81·5	68·7	75·1	+ 1·2	71·1	90	9·0	17·04	+ 4·72	29	3·9	31
Zomba, Nyasaland	1018·2	+ 1·4	83	48	70·9	53·0	61·9	− 3·0	55·1	67	5·1	0·28	− 0·09	5	...	...
Salisbury, Rhodesia...	1020·7	− 0·5	80	34	69·4	41·8	55·6	− 4·6	46·5	45	2·1	0·22	+ 0·16	1	8·9	77
Cape Town	1021·7	+ 1·4	82	41	67·4	49·3	58·3	+ 2·7	49·7	79	3·6	3·40	+ 0·03	8	...	...
Johannesburg	1023·1	+ 0·6	74	23	60·9	37·2	49·1	− 5·3	38·7	53	2·0	0·41	− 0·10	1	9·9	89
Mauritius	1018·9	− 1·6	80	56	75·9	61·7	68·8	+ 0·3	66·0	74	4·2	1·32	− 1·03	8	8·1	71
Calcutta, Alipore Obsy.	1002·6	+ 1·6	93	74	88·9	78·7	83·8	+ 0·6	79·3	90	8·5	11·79	− 1·59	16*	...	...
Bombay	1006·4	+ 0·5	87	73	85·0	76·5	80·7	− 0·1	76·5	87	9·3	16·69	+ 2·24	14*	...	...
Madras	1005·5	0·0	101	69	92·6	76·8	84·7	− 1·3	75·7	75	8·0	9·07	+ 4·53	11*	...	...
Colombo, Ceylon	1010·0	+ 0·7	86	71	84·1	76·0	80·1	− 1·1	75·9	79	7·9	7·87	+ 4·63	21	5·8	47
Singapore..................	1010·0	+ 0·5	89	73	85·6	76·6	81·1	0·0	77·2	79	6·5	7·25	− 0·70	19	6·7	55
Hongkong..................	1004·4	− 0·4	93	75	87·6	78·2	82·9	+ 0·8	78·9	82	6·2	6·03	− 8·37	10	7·0	55
Sandakan	1009·6	...	92	71	89·2	74·9	82·1	+ 0·3	76·8	80	5·2	10·18	+ 2·29	16	...	...
Sydney, N.S.W..........	1019·0	+ 0·8	78	41	66·3	47·4	56·9	+ 1·9	50·1	67	4·0	0·22	− 2·75	3	7·9	72
Melbourne	1018·2	+ 0·2	72	39	60·4	45·3	52·9	+ 1·9	48·4	74	5·9	1·43	− 0·44	18	4·3	41
Adelaide	1018·9	− 0·4	79	39	64·6	47·9	56·3	+ 2·4	50·5	67	6·3	3·22	+ 0·69	15	5·9	55
Perth, W. Australia ...	1018·7	− 0·2	77	37	64·6	47·5	56·1	+ 0·1	49·7	63	4·6	3·97	− 1·68	15	7·2	66
Coolgardie	1019·0	− 0·3	78	32	63·2	40·6	51·9	− 1·7	48·6	75	4·1	0·74	− 0·25	8	...	...
Brisbane....................	1021·1	+ 1·9	78	43	70·1	49·7	59·9	− 0·5	53·4	67	3·6	1·64	− 0·37	9	8·1	73
Hobart, Tasmania......	1012·2	− 1·2	69	34	56·0	43·3	49·7	+ 1·7	45·1	72	5·5	2·08	+ 0·25	17	5·1	49
Wellington, N.Z.	1011·4	− 3·7	63	33	54·4	42·0	48·2	− 0·4	45·0	71	3·9	3·42	− 1·07	10	6·6	63
Suva, Fiji	1015·0	+ 0·8	85	64	78·5	69·6	74·1	+ 0·5	70·0	86	7·8	16·59	+ 8·30	24	3·0	26
Apia, Samoa	1012·1	− 0·2	88	71	84·2	73·6	78·9	+ 1·1	75·3	79	5·5	8·73	+ 5·10	16	7·3	62
Kingston, Jamaica	1012·8	− 0·7	91	71	87·2	73·0	80·1	− 1·4	72·3	83	4·6	4·65	+ 1·10	10	6·8	54
Grenada, W.I.	...	...	89	72	86	74	80	+ 0·3	74	74	5	9·37	+ 0·04	20	...	...
Toronto.....................	1014·9	− 0·5	89	46	79·0	60·8	69·9	+ 2·7	62·8	81	3·8	0·45	− 2·34	6	8·4	60
Winnipeg	1012·7	− 0·5	95	34	74·3	52·9	63·6	− 0·2	54·2	87	5·0	4·75	+ 2·59	12	8·0	55
St. John, N.B.	1014·2	− 1·1	90	48	73·4	55·7	64·5	+ 3·9	59·6	80	5·4	2·31	− 1·55	12	7·4	52
Victoria, B.C.............	1016·5	− 0·4	88	47	68·4	52·0	60·2	+ 0·5	55·3	75	3·8	0·53	− 0·11	3	10·0	70

* For Indian stations a rain day is a day on which 0·1 in. or more rain has fallen.

(30284) Wt. 18/32 1,050 2/36 Hw. G.377 S.O. Code No. 40-43-1-

*For Indian stations a rain day is a day on which 0·1 in. or more rain has fallen.

St. John, N.B.	1014·2	— 1·1	90	48	73·4	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Victoria, B.C..............	1016·5	— 0·4	88	47	68·4	52·0	60·2	+ 0·5	55·3	75	3·8	0·53	— 0·11	3	10·0	70

* For Indian stations a rain day is a day on which 0·1 in. or more rain has fallen.